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# METHOD FOR MANUFACTURING LIQUID CRYSTAL DISPLAY PANEL

[Abstract]

PROBLEM TO BE SOLVED: To prevent production of air bubbles as defects.

SOLUTION: After a TFT substrate 1 and a CF substrate 2 are disposed in a vacuum decompression chamber 5 with the electrode forming surfaces of the substrates facing each other, water vapor is introduced into the vacuum decompression chamber 5 to replace the whole air with water vapor and to evacuate, for example, to 100 [Pa]. Then an upper stage 7 is lowered to overlap the CF substrate 2 with the TFT substrate 1 and to lightly press them. Then the external air is introduced to return the pressure in the vacuum decompression chamber 5 to the atmospheric pressure. Thus, the CF substrate 2 and the TFT substrate 1 are pressed to each other by the atmospheric pressure to form a regulated gap t between the TFT substrate 1 and the CF substrate 2. The liquid crystal 3 fills the layer region 23 while the sealing material 22 is crushed to adhere the TFT substrate 1 to the CF substrate 2. The water vapor in the layer region 23 reduces its volume with increase in the pressure and further transits to water as

liquid and air bubbles disappear.

**[Claim(s)]**

[Claim 1] A manufacturing method of a liquid crystal display panel, wherein liquid crystal is injected between a pair of corresponding panel substrates on which electrodes are formed, comprising at least:

a seal member coating process for coating a seal member on the displaying region of the surface of one of the panel substrates on which at least an electrode of said one panel substrate is formed;

a liquid crystal dropping process for dropping said liquid crystal onto the displaying region of the surface of one of panel substrates on which at least an electrode of said one panel substrate is formed;

a substrate bonding process for maintaining said first condition and for bonding said both panel substrates with said seal member and said liquid crystal being sandwiched therebetween, under an atmosphere including predetermined materials representing atmospheric phenomena and the first condition that at least one of pressure or temperature is set to a value within a predetermined range; and

a substrate pressing process for pressing said both panel substrates, wherein in the substrate pressing process, at least one of pressure or temperature is changed from the value of said first condition to a value of a second condition, and in the first condition, an atmosphere is represented, and in said second condition of the

substrate pressing process, a material, which is changed into a liquid state, is used.

[Claim 2] A manufacturing method of a liquid crystal display panel, wherein liquid crystal is injected between a pair of corresponding panel substrates on which electrodes are formed, is characterized in that

a seal member coating process for coating a seal member on the displaying region of the surface of the one of the panel substrates on which at least an electrode of said one panel substrate is formed,

a liquid crystal dropping process for dropping said liquid crystal into the displaying region of the surface of one of the panel substrates on which at least an electrode of said one panel substrate is formed,

a substrate bonding process for maintaining said first condition and for bonding said both panel substrates with said seal member and said liquid crystal being sandwiched therebetween, under the atmosphere including predetermined materials representing atmospheric phenomena and the first condition that pressure is reduced to a value within a predetermined range, and

a substrate pressing process for pressing said both panel substrates, wherein the substrate pressing process, pressure is set as a value of a second conditio increased from the value of said first condition, and as for said predetermined material, in the first condition of the substrate bonding process, an atmosphere is

represented, and in said second condition of the substrate pressing process, a material, which is changed into a liquid state, is used.

[Claim 3] A manufacturing method of a liquid crystal display panel, wherein liquid crystal is injected between a pair of corresponding panel substrates on which electrodes are formed, is characterized in that

a seal member coating process for coating a seal member on the displaying region of the surface of one of the panel substrates on which at least an electrode of said one panel substrate is formed,

a liquid crystal dropping process for dropping said liquid crystal onto the surface of one of the panel substrates on which at least an electrode of said one panel substrate is formed,

a substrate bonding process for maintaining said first condition and for bonding said both panel substrates with said seal member and said liquid crystal being sandwiched therebetween, under the atmosphere including predetermined materials representing atmospheric phenomena and the first condition that temperature is increased to a value within a predetermined range, and a substrate pressing process for pressing said both panel substrates,

wherein the substrate pressing process, temperature is set as a value of a second condition reduced from the value of said first condition, and as for said

predetermined material, in the first condition of the substrate bonding process, an atmospheric phenomenon is represented, and in said second condition of the substrate pressing process, a material, which is changed into a liquid state, is used.

[Claim 4] A manufacturing method of a liquid crystal panel, wherein liquid crystal is injected between a pair of corresponding panel substrates on which electrodes are formed, is characterized in that

a seal member coating process for coating a seal member on the displaying region of the surface of one of the penal substrates on which at least an electrode of said one panel substrate is formed,

a liquid crystal dropping process for dropping said liquid crystal onto the displaying region of the surface of one of the penal substrates on which at least an electrode of said one panel substrate is formed,

a substrate superimposing process for maintaining said first condition and for superimposing said both panel substrates with said seal member and said liquid crystal being sandwiched therebetween, under the atmosphere including predetermined materials representing atmospheric phenomena with the first condition that pressure is reduced to a value within a predetermined range and temperature is increased to a value within a predetermined range, and

a substrate pressing process for pressing said both panel substrates,

wherein in the substrate pressing process, a value of a second condition which returns pressure and temperature nearly to normal temperature and a normal pressure is set, and as for said predetermined material, in the first condition of the substrate superimposing process, an atmospheric phenomenon is represented, and in said second condition of the substrate pressing process, a material,which is changed into a liquid state, is used.

[Claim 5] The method according to claim 1, wherein, in a substrate bonding process, said atmosphere is consisted mainly of predetermined material.

[Claim 6] The method according to claim 1, wherein said atmosphere is consisted mainly of various kinds of the predetermined material.

[Claim 7] The method according to claim 1, wherein a boiling point of said predetermined material is above approximately 40°C.

[Claim 8] The method according to claim 5, wherein said predetermined material is water.

[Claim 9] The method according to claim 5, wherein said predetermined material is ethyl alcohol.

[Claim 10] The method according to claim 1, wherein said atmosphere includes a compound comprising said predetermined material, and a material which has

relatively higher solubility than that of said predetermined material of a liquid state.

[Claim 11] The method according to claim 10, wherein said atmosphere includes water and ammonia.

**[Title of the Invention]**

A MANUFACTURING METHOD OF LIQUID CRYSTAL DISPLAY PANEL

**[Detailed Description of the Invention]**

[Field of the Invention]

The present invention is related to A manufacturing method of a liquid crystal display panel used for a display apparatus.

[Description of the Prior Art]

Up to now, a LCD(liquid crystal display) panel has been used widely as a display means in TV monitor, or display devices for OA equipments. This LCD panel is manufactured as follows. For example, after a seal member is coated on one peripheral side of a pair of transparent glass substrates, liquid crystal is dropped into a pair of transparent glass substrates, two transparent glass substrates are superimposed and pressed, and liquid crystal is sealed (hereinafter, refer to as "an one-drop fill injection method"). As is described in Japanese laid-Open patent Publication NO. 8-190099, for example, in such one-drop fill injection method, a TFT substrate 101 to which a TFT(Thin Film Transistor) and a pixel electrode are connected, and a color filter substrate(below, CF substrate is called) 102 on which a color filter and a common electrode are formed are prepared at the

intersection point where a signal line and a scan line are intersected in a matrix type. Next, as shown in FIG. 10(a), a ball-shaped spacer 103 having a same diameter and a designated substrate t (for example, 5μm) are distributed (scattered) on CF substrate 2. Then, a seal member 104 is coated on a circular shape of a corner surrounding a display region on TFT substrate 101, a predetermined amount of liquid crystal 105 is dropped to the center of said display region, and accommodated into a vacuum container. Then, for example, under the reduced pressure such as 100[Pa], both substrates 101, 102 are faced each other, and superimposed. CF substrate 102 are pressed against a TFT substrate 101 lightly, and as shown in FIG. 10(b), the superimposed both substrates 101, 102 are pulled out to the atmosphere. Therefore, as shown in FIG. 11, a LCD panel having a sealed liquid crystal 105, and a designated substrate gap which is same to a diameter of a spacer 103 are obtained.

[Problems to be Solved by the Invention]

But, in the conventional art, when both substrates 101, 102 are superimposed, an air having 100[Pa] are introduced between both substrates 101, 102. When the atmospheric pressure is set, as shown in FIG. 11, an air is compressed and is sealed as foam 106 into a LCD panel. This bubble 106 is found in the display region. Therefore, there is a problem that quality of a display panel is deteriorated. In addition, when reducing the gas amount(weight or

material weight) received into the gap of both substrates 101, 102 by lowering the pressure of an atmosphere in a vacuum container when bonding both substrates 101, 102, there was a problem that the pressure in the vacuum container have the difficulty in suction-adhering and supporting, for example, at the level lower than 100[Pa] in case of adhering and supporting a CF substrate 102 by giving a CF substrate 102 arranged on the upper side a floating pressure with introduced air. Further, even if an upper CF substrate 102 is supported by using other methods except said suction-adhering and supporting method, since it takes a log time to achieve a desired vacuum level, and a large and expensive vacuum device is required, there is a problem that it takes a long time and much costs to produce a LCD panel.

The present invention is proposed by taking these problems into consideration, and the object of the present invention is to provide a manufacturing method of a liquid crystal display panel, wherein liquid crystal in which prevents generation of foams as a defect, and can produces a high-quality LCD panel with a low cost without requiring a large vacuum device and a long time, and without selecting a method for supporting a substrate arranged on the upper side when superimposing both substrates.

[Means for Solving the Problem]

In order to solve above-mentioned problems, the invention described in the

claim 1 is a manufacturing method of a liquid crystal display panel, wherein liquid crystal is injected between a pair of opposing panel substrates on which electrodes are formed, and is characterized in that it comprises a seal member coating process for coating a seal member on outside region of a display region of a surface of a side on which at least an electrode of said one panel substrate is formed, a liquid crystal dropping process for dropping said liquid crystal into the display region of a surface of a side on which at least an electrode of said one panel substrate is formed, a substrate bonding process for maintaining said first condition and for bonding said both panel substrates with said seal member and said liquid crystal being sandwiched therebetween, under an atmosphere including predetermined materials representing atmospheric phenomena and the first condition that at least one of pressure or temperature is set to a value within a predetermined range, and a substrate pressing process for pressing said both panel substrates, wherein in the substrate pressing process, at least one of pressure or temperature is changed from the value of said first condition to a value of a second condition, and in the first condition, an atmosphere is represented, and in said second condition of the substrate pressing process, a material which is changed into a liquid state is used.

Further, the invention described in the claim 2 is a manufacturing method of a liquid crystal display panel, wherein liquid crystal is injected between a pair of

opposing panel substrates on which electrodes are formed, and is characterized in that it comprises a seal member coating process for coating a seal member on outside region of a display region of a surface of a side on which at least an electrode of said one panel substrate is formed, a liquid crystal dropping process for dropping said liquid crystal into the display region of a surface of a side on which at least an electrode of said one panel substrate is formed, a substrate bonding process for maintaining said first condition and for bonding said both panel substrates with said seal member and said liquid crystal being sandwiched therebetween, under the atmosphere including predetermined materials representing atmospheric phenomena and the first condition that pressure is reduced to a value within a predetermined range, and a substrate pressing process for pressing said both panel substrates,

wherein in the substrate pressing process, pressure is set as a value of a second condition increased from the value of said first condition, and as for said predetermined material, in the first condition of the substrate bonding process, an atmosphere is represented, and in said second condition of the substrate pressing process, a material which is changed into a liquid state is used.

Further, the invention described in the claim 3 is a manufacturing method of a liquid crystal display panel, wherein liquid crystal is injected between a pair of opposing panel substrates on which electrodes are formed, and is characterized in

that it comprises a seal member coating process for coating a seal member on outside region of a display region of a surface of a side on which at least an electrode of said one panel substrate is formed, a liquid crystal dropping process for dropping said liquid crystal into the display region of a surface of a side on which at least an electrode of said one panel substrate is formed, a substrate bonding process for maintaining said first condition and for bonding said both panel substrates with said seal member and said liquid crystal being sandwiched therebetween, under the atmosphere including predetermined materials representing atmospheric phenomena and the first condition that temperature is increased to a value within a predetermined range, and a substrate pressing process for pressing said both panel substrates,

wherein in the substrate pressing process, temperature is set as a value of a second condition reduced from the value of said first condition, and as for said predetermined material, in the first condition of the substrate bonding process, an atmospheric phenomenon is represented, and in said second condition of the substrate pressing process, a material which is changed into a liquid state is used.

Further, the invention described in the claim 4 is a manufacturing method of a liquid crystal panel, wherein liquid crystal is injected between a pair of opposing panel substrates on which electrodes are formed, and is characterized in that it comprises a seal member coating process for coating a seal member on outside

region of a display region of a surface of a side on which at least an electrode of said one panel substrate is formed, a liquid crystal dropping process for dropping said liquid crystal into the display region of a surface of a side on which at least an electrode of said one panel substrate is formed, a substrate superimposing process for maintaining said first condition and for superimposing said both panel substrates with said seal member and said liquid crystal being sandwiched therebetween, under the atmosphere including predetermined materials representing atmospheric phenomena and the first condition that pressure is reduced to a value within a predetermined range and temperature is increased to a value within a predetermined range, and a substrate pressing process for pressing said both panel substrates,

wherein in the substrate pressing process, a value of a second condition which returns pressure and temperature nearly to normal temperature and a normal pressure is set, and as for said predetermined material, in the first condition of the substrate superimposing process, an atmospheric phenomenon is represented, and in said second condition of the substrate pressing process, a material which is changed into a liquid state is used.

Further, the invention described in the claim 5 is a manufacturing method of a liquid crystal display panel set forth in the claim 1 and is characterized in that in a substrate bonding process, said atmosphere is consisted mainly of predetermined

material.

Further, the invention described in the claim 6 is a manufacturing method of a liquid crystal display panel set forth in the claim 1 and is characterized in that said atmosphere is consisted mainly of various kinds of the predetermined material.

Further, the invention described in the claim 7 is a manufacturing method of a liquid crystal display panel set forth in the claim 1 and is characterized in that a boiling point of said predetermined material is above approximately 40°C.

Further, the invention described in the claim 8 is a manufacturing method of a liquid crystal display panel set forth in the claim 5 and is characterized in that said predetermined material is water.

Further, the invention described in the claim 9 is a manufacturing method of a liquid crystal display panel set forth in the claim 5 and is characterized in that said predetermined material is ethyl alcohol.

Further, the invention described in the claim 10 is a manufacturing method of a liquid crystal display panel set forth in the claim 1 and is characterized in that said atmosphere includes a compound comprising said predetermined material, and a material which has relatively higher solubility than that of said predetermined material of a liquid state.

Further, the invention described in the claim 10 is a manufacturing method

of a liquid crystal display panel set forth in the claim 10 is characterized in that said atmosphere includes water and ammonia.

[Embodiment of the Invention]

Below, the embodiment of the present invention will be explained with referring to the drawings. Explanation will be made by using the embodiments in detail.

FIG. 1 - FIG. 8 are the drawings for explaining a manufacturing method of a liquid crystal display panel, which is one embodiment of the present invention.

Further, FIG. 9 shows a structure of the same liquid crystal display panel schematically. By referring to FIG. 1 - FIG. 8, a manufacturing method of a liquid crystal display panel according to this embodiment will be explained.

First of all, summary of this embodiment will be explained. In this method, a signal line and a scan line are arranged in a matrix type on a transparent glass substrate. CF substrate(a panel substrate) 2 on which a color filter 2a and a common electrode are formed on the transparent glass substrate, and TFT substrate panel(a panel substrate) 1 for connecting TFT and a pixel electrode at this intersection are prepared. As shown in FIG. 1 - FIG. 4, after dropping liquid crystal 3 on TFT substrate 1, TFT substrate 1 and CF substrate 2 are accommodated into a vacuum pressure reduction container 5 of a manufacturing

device 4 of a liquid crystal display panel for bonding, and then liquid crystal 3 is sealed. Next, a manufacturing device 4 of a liquid crystal display panel will be explained. As shown in FIG. 1 - FIG. 4, a manufacturing device 4 of a liquid crystal display panel is composed of a vacuum pressure reduction container 5, a lower stage 6 for mounting a TFT substrate 1 arranged facing with each other in the vacuum pressure reduction container 5, an upper stage 7 for absorbing and maintaining a CF substrate 2, a press device 8 using a cylinder for moving the upper stage 7 along the perpendicular direction, a position adjustment device 9 for moving the lower stage 6 in the horizontal plane or rotating it around rotation axis, an exhaust pipe 12 connected to a vacuum pump 11 for discharging a gas of the vacuum pressure reduction container 5, a leak pipe 13 for absorbing an air except the vacuum pressure reduction container 5, a steam suction pipe 15 for guiding steam into the vacuum pressure reduction container 5 from a receiving container 14, an exhaust valve 16 for adjusting amount of a gas discharged toward the vacuum pump 11 from the exhaust pipe 12, a leak valve 17 for adjusting a flow amount of an air introduced into the vacuum pressure reduction container 5 from the other portions except the vacuum pressure reduction container 5, and a suction valve 18 for adjusting a flow amount of steam introduced into the vacuum pressure reduction container 5 from the steam suction pipe 15.

Next, a manufacturing method of this embodiment will be explained in detail.

As shown in FIG. 5, a ball-shaped spacer 18a and a cylinder-shaped spacer 19b for regulating the distance between TFT substrate 1 and CF substrate 2 are distributed, and adhered by a heating process. At this time, a diameter of the spacer 19a is for example 5μm, which is same to t space that is a designated distance between the substrates. The spacer 19a is distributed within a display region 20 on which a color filter 2a of CF substrate 2 is formed while liquid crystal being inserted between a display region of TFT substrate 1, and CF substrate 2. A diameter of the spacer 19b is for example 6μm, and is distributed within a nearly circular-shaped region surrounding the display region of CF substrate 2. Next, as shown in FIG. 6, a seal member 22 made of an ultraviolet ray hardening resin is dropped in a circular shaped region for surrounding a display region having width size a, and length size b of an electrode forming side of TFT substrate 1. A liquid crystal 3 of a predetermined amount of VL is dropped into the center portion of the display region 21. At this time, it is preferable that a dropping amount VL of liquid crystal 3 is same to the volume of a space V0(V0= abt) formed between the TFT substrate 1 and CF substrate 2, until the gap between the TFT substrate 1 and CF substrate 2 reaches to a designated substrate distance t when the TFT substrate 1 and CF substrate 2 are pressed. But it is preferable that actual a dropping amount VL of liquid crystal 3 ranges from 100% to 110% of V0 in light of the volume of a space or non-uniformity of production. It is more preferable that actual a dropping amount VL of liquid crystal 3 ranges from 100% to 130% of V0.

Next, as shown in FIG. 1, the TFT substrate 1 and CF substrate 2 are arranged in the vacuum pressure reduction container 5 so that the electrode forming side of the TFT substrate 1 faces the electrode forming side of CF substrate 2. More particularly, specific, a TFT substrate 1 is arranged on the lower stage 6, and a CF substrate 2 is supported by adsorption of the CF substrate on the lower side of the upper stage 7.

Next, after the position alignment between the TFT substrate 1 and CF substrate 2 is performed by using the position adjustment device 9, the vacuum pump 11 is operated by opening the exhaust valve 16, a gas is discharged from the exhaust valve 12, the pressure of the vacuum pressure reduction container 5 is reduced to the predetermined pressure p1(for example, p1 = 100[Pa]). Next, once the vacuum pump 12 is stopped, the exhaust valve 16 is closed, the suction valve 18 is opened, steam is introduced into the vacuum pressure reduction container 5 from the steam suction valve 15, and all airs in the vacuum pressure reduction container 5 are changed into steam.

Next, the suction valve 18 is closed, the exhaust valve 16 is opened, the vacuum pump is operated once again, the air in the vacuum pressure reduction container 5 is reduced to the pressure p1. Next, as shown in FIG. 2, the upper stage 7 is lowered by the press device 8, and as shown in FIG. 7, CF substrate 2 is adhered on the TFT substrate 1. When CF substrate 2 is adhered on the TFT

substrate 1, the volume V1 of steam collected into layer-shaped region 23 formed between CF substrate 2 and the TFT substrate 1 is obtained as follows. For example, in case of corresponding liquid crystal display panel of 14 type, if length size a and width size b are set to (a=216.1mm, b=287.5mm), respectively, at this time, the height h of the layer-shaped region 23 is set to 30μm, and the dropping amount VL(=V0) of liquid crystal 3 is set to m3, $VL=ab(h-t)=1.5\times10-6[m3]$

Next, as shown in FIG. 3, the upper stage 7 is lowered by the press device 8, and CF substrate 2 is pressed against the TFT substrate 1 lightly. Corresponding to the pressure, the layer-shaped region 12 between CF substrate 2 and the TFT substrate 1 is filled with liquid crystal 3, and at the same time, the steam collected in the layer-shaped region 23 is being compressed. Further, the seal member is pressed step by step.

Next, as shown in FIG. 4, the vacuum pump 11 is stopped, an exhaust valve 16 is closed, a leak valve 17 is opened, an outside air is introduced from the leak pipe 13, inside of the vacuum pressure reduction container 5 is returned to an atmospheric pressure p0. Therefore, as shown in FIG. 8, CF substrate 2 and the TFT substrate 1 are pressed more by the atmospheric pressure p0, and thereby the gap between CF substrate 2 and the TFT substrate 1 becomes the designated distance t which is same to the diameter of the spacer 19a. At this time, the layer-shaped region 23 is filled with liquid crystal 3, and the seal member 22 is pressed.

Therefore, CF substrate 2 and the TFT substrate 1 are adhered. In addition, as the steam pressure in the layer-shaped region 23 increases from p1 to p0, the volume is reduced and is changed into water as a liquid. If the atmospheric pressure p0 is set to an ambient pressure (=101325[Pa] : standard atmospheric pressure), and the volume of water becomes 1/2000, the volume V2 of the remaining water in the layer-shaped region 23 becomes V1p1/2000p0 = 7.65 10-13[m3]. If the water is ball-shaped, the radius r1 is 56.8[μm]. Thus, it can be neglected.

Further, a process for bonding CF substrate 2 and the TFT substrate 1, and a pressing process are performed under the normal temperature (15°C to 20°C). Then, CF substrate 2 and the TFT substrate 1 are pulled from the vacuum pressure reduction container 5, an ultraviolet rays are illuminated on the seal member 22 by an ultraviolet lamp, the seal member 22 is hardened and sealing is completed. Therefore, under the state that bubbles are lost, liquid crystal 3 is not leaked, and is sealed between CF substrate 2 and the TFT substrate 1 with the seal member 22 being sandwiched therebetween. Then, cutting, inspection, and adding of a polarized plate are performed. Accordingly, a liquid crystal display panel can be obtained as shown in FIG. 9.

In this way, the liquid crystal display panel 23 produced as above, for example, is a panel of transmission type, and as shown in FIG. 9, includes the fixed

CF substrate 2 and the TFT substrate 1 which face each other with a gap of about 5μm therebetween, liquid crystal layer 24 which is sealed into the gap, and a pair of polarized plate 25, 26 arranged on exterior side of CF substrate 2 and the TFT substrate 1. At this time, TFT substrate 1is formed by arranging a signal line 1a and a scan line 1b in a matrix type on a transparent glass substrate, and by connecting TFT1c and a pixel electrode 1d at this intersection. On CF substrate 2, a color filter 2a and a common electrode 2b are formed on the transparent glass substrate. The liquid crystal display panel 23 is introduced into a module process including a terminal connecting process and a print mounting process, and thus LCD apparatus is produced. Since the boiling point of water is 100°C and bubbles are not generated in the liquid crystal layer 24 of the liquid crystal display panel 23 until an usage environment temperature of a LCD apparatus reaches to 100,

In this way, according to the structure of this embodiment, the volume of steam received when bonding CF substrate 2 and the TFT substrate 1 is reduced according to the applied pressure, and if the atmospheric pressure is returned, since the steam becomes water as a liquid, foams are lost, and the volume of remaining water is negligible, foams and liquid crystal are sealed between CF substrate 2 and the TFT substrate 1. Therefore, it is possible to prevent defects of display from being generated. Further, when bonding CF substrate 2 and the TFT substrate 1, since liquefied water(steam) is used as an atmosphere at a normal

temperature and a normal pressure, it is possible to acquire above-mentioned effects without lowering the pressure of this atmosphere below a required level. Therefore, a method for suction-adhering and supporting CF substrate 2 arranged on th upper side by attachment is used. It is possible to bond CF substrate 2 and the TFT substrate 1, and to produce high-quality LCD panel at low cost without requiring a long time.

Until now, the embodiment of the present invention was explained with referring to the drawings, but specific structure is not limited to this embodiment. The design changes can be included into the present invention as far as they do not depart from the scope of the present invention. For example, in the embodiment, a case that both substrates are bonded under the state that a temperature is set to a normal temperature is described, but is not limited to this. A case that the temperature of bonding is set to, for example, about 90°C, the temperature is lowered to a normal temperature, and the atmospheric (steam) pressure of bonding is increased by the lowered amount can be applied.

Therefore, it is achieve a necessary vacuum level within a short time. In addition, it is preferable that the atmosphere is not limited to water, and for example, organic solvents such as acetone, ether such as ethyl ether, and alcohol such as ethyl alcohol are used. In this way, it is possible to even at relatively low temperature by using a material having a boiling point lower than that of water.

Further, it is also preferable that while keeping a pressure as a normal pressure, for example, a steam exceeding 100 is introduced when bonding CF substrate 2 and the TFT substrate 1, both substrates are pressed until designated substrate gap is reached to t by a press device, and then the temperature is lowered a normal temperature. Therefore, it is not necessary to reduce the inside pressure of the vacuum pressure reduction container 5. At this time, a step for changing from 90 to a normal temperature may be performed without reducing the pressure by using a material having a boiling point lower than that of water such as methyl alcohol or ethyl alcohol.

Further, in connection with an atmosphere, for example, it is possible to use a compound comprising water(steam) and an alcohol, or use a mixed gas including three kinds of materials. Further, it is possible to introduce a mixed gas formed by adding for example, ammonia having relatively higher solubility than that of water to water(steam), into both substrates when bonding. Further, before returning the atmospheric pressure, it is preferable that both substrates are pressed such that a gap between them becomes a designated distance t, and a spacer is distributed on the TFT substrate.

[Effect of the Invention]

As is explained above, according to this invention, under the second condition, the predetermined material of a gas state accommodated into both

substrates by the substrate bonding process becomes liquid and then foams are lost. The volume of remaining liquid is very small so that it is negligible. Therefore, it is possible to prevent display defects from being created due to a phenomenon that foams are sealed between both panel substrates. Further, it is possible to obtain the above-mentioned effects without lowering the atmospheric pressure below a necessary level in the substrate bonding process. Therefore, for example, a method for adhering and supporting a panel substrate arranged on the upper side by the substrate bonding process is used. Therefore, It is possible to bond both panel substrates, and to produce high-quality LCD panel at low cost without requiring a long time. Further, it is possible to produce a high-quality LCD panel since expensive vacuum device for obtaining high vacuum level is not required.

**[Description of Drawings]**

FIG. 1 illustrates a manufacturing method of a liquid crystal display panel of the present invention.

FIG. 2 illustrates an alternative manufacturing method of the liquid crystal display panel.

FIG. 3 illustrates an alternative manufacturing method of the liquid crystal display panel.

FIG. 4 illustrates an alternative manufacturing method of the liquid crystal display panel.

FIG. 5 illustrates an alternative manufacturing method of the liquid crystal display panel.

FIG. 6 illustrates an alternative manufacturing method of the liquid crystal display panel.

FIG. 7 illustrates an alternative manufacturing method of the liquid crystal display panel.

FIG. 8 illustrates an alternative manufacturing method of the liquid crystal display panel.

FIG. 9 is a schematic perspective view illustrating a construction of the liquid crystal display panel.

FIG. 10 illustrates a manufacturing method of an liquid crystal display panel according to prior art.

FIG. 11 illustrates an alternative manufacturing method of the liquid crystal display panel according to prior art.

[Meaning of numerical symbols in the drawings]

1 : TFT substrate (panel substrate) 2 : CF substrate (panel substrate)

3 : liquid crystal

4 : apparatus for manufacturing liquid crystal display panel

19a, 19b : spacer 20, 21 : display region

22 : sealant 23 : liquid crystal display panel